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IS 6008 (1989): Arc Welding Power Source, Single Operator Rectifier Type, ac and dc [ETD 21: Electric Welding Equipment]



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Indian Standard

**ARC WELDING POWER SOURCE,
SINGLE OPERATOR RECTIFIER TYPE,
ac AND dc — SPECIFICATION**

(First Revision)

भारतीय मानक

आर्क वेल्डिंग पावर स्रोत, एक-प्रचालक रेक्टिफायर
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FOREWORD

This Indian Standard (First Revision) was adopted by the Bureau of Indian Standards on 24 February 1989, after the draft finalized by the Electric Welding Equipment Sectional Committee had been approved by the Electrotechnical Division Council.

This standard was first published in 1971. In this revision effort has been made to align the requirements with IS 4559 : 1986 'Specification for single operator rectifier type dc arc welding power source (*first revision*)'.

This standard deals with ac and dc arc welding power sources incorporating solid state rectifiers.

Rectifier type arc welding power source could be either with ac and dc output or dc output only. This standard is intended to cover the former type only, while IS 4559 : 1986 deals with the latter type.

In preparing this standard, assistance has been derived from the following:

- a) ISO 700-1982 Power sources for manual metal arc welding with covered electrodes and for the TIG process. International Organization for Standardization (ISO).
- b) BS 638 : Part 2 : 1979 Arc-welding power sources, equipment and accessories, Part 2 Specification for air cooled power sources for manual metal-arc welding with covered electrodes and for TIG welding. British Standards Institution.
- c) EW 1-1983 Electric arc-welding power sources. National Electric Manufacturers' Association, USA.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

ARC WELDING POWER SOURCE, SINGLE OPERATOR RECTIFIER TYPE, ac AND dc — SPECIFICATION

(*First Revision*)

1 SCOPE

1.1 This standard lays down the requirements and tests for single operator ac/dc arc welding power source incorporating solid state rectifiers and having drooping characteristics.

1.2 This standard does not cover 'constant potential' and other special types of rectifier arc welding power sources.

2 REFERENCES

2.1 The following Indian Standards are necessary adjuncts to this standard:

<i>IS No.</i>	<i>Title</i>
IS 1248 (Part 2) : 1983	Specification for direct acting indicating analogue electrical measuring instruments and their accessories, Part 2 Ammeters and voltmeters (<i>second revision</i>)
IS 1271 : 1985	Thermal evaluation and classification of electrical insulation (<i>first revision</i>)
IS 2511 : 1963	Specification for polycrystalline semi-conductor rectifier stacks
IS 2834 : 1986	Specification for shunt capacitors for power systems (<i>second revision</i>)
IS 3895 : 1966	Specification for monocrystalline semi-conductor rectifier cells and stacks
IS 4559 : 1986	Specification for single operator rectifier type dc arc welding power source (<i>first revision</i>)
IS 9678 : 1980	Methods of measuring temperature-rise of electrical equipment

3 TERMINOLOGY

3.0 For the purpose of this standard, the following definitions shall apply.

3.1 Automatic Arc Welding

Metal-arc welding in which the arc length and the travel of electrodes or the work pieces are automatically controlled.

3.2 Duty Cycle

The ratio of time during which the output side of the arc welding power sources is loaded, to the total elapsed time, the primary side being energized throughout.

3.3 Load Characteristics

The specified relationship between load voltage and load current of arc welding power source.

3.4 Load Voltage

The voltage between the output terminal of the arc welding power source when a specified current is flowing.

3.5 Manual Metal-Arc Welding (Hand Welding)

Metal arc welding with consumable electrodes not exceeding 460 mm in length and applied by the operator without automatic or semi-automatic means of replacement.

3.6 Maximum Continuous Automatic Welding Current

The maximum welding current which the arc welding power source is capable of delivering for continuous operation on automatic or semi-automatic arc welding at specified load voltage and duty cycle without exceeding the specified temperature-rise.

3.7 Maximum Continuous Hand Welding Current

The maximum welding current which the welding power source is capable of delivering when engaged continuously for manual metal-arc welding, at the specified load voltage and duty cycle without exceeding the specified temperature-rise.

3.8 Maximum Hand Welding Current

The maximum welding current for which the arc welding power source is calibrated for manual metal-arc welding at the specified load voltage.

3.9 Minimum Automatic Welding Current

The minimum welding current for which the arc welding power source is calibrated for automatic or semi-automatic welding at the specified load voltage.

3.10 Minimum Hand Welding Current

The minimum welding current for which the arc welding power source is calibrated for manual metal-arc welding at the specified load voltage.

3.11 Open Circuit Voltage

The voltage between the output terminals of the arc welding power source when no current is flowing in the welding circuit.

NOTE — This does not include superimposed high frequency voltage and voltage derived from low voltage safety device.

3.12 Rating

A statement of operating parameters assigned to the arc welding power source by the manufacturer under specified conditions.

3.13 Routine Tests

Tests carried out on each arc welding power source to check requirements which are likely to vary during production.

3.14 Semi-Automatic Arc Welding

Metal-arc welding in which the arc length is automatically controlled but the positioning of the arc is manual.

3.15 Type Tests

Tests made on an arc welding power source which is representative of other arc welding power sources to demonstrate that they comply with specified requirements not covered by tests to which each individual power source is subjected.

NOTE — An arc welding power source is considered to be representative of others if it is identical in rating and construction.

4 RATING

4.1 Rated Input Voltage

The preferred rated input voltage shall be 240 V or 415 V.

NOTE — In case of a rectifier type arc welding power source suitable for 415 volts, supply should be taken either from two lines or three lines of three phase supply

depending upon whether the power source is designed for connection to two or three lines of a three phase system.

4.2 Rated Frequency

The rated frequency shall be 50 Hz.

4.3 Rated Open-Circuit Voltage

The open-circuit voltage of the arc welding power source shall not exceed 100 V for ac/dc output.

NOTE—Where it is required to control the open-circuit voltage for safety purposes, suitable safety devices may be incorporated to bring voltage down to the desired value.

4.4 Rated Current

The ac/dc arc welding power source shall be rated at current and duty cycles corresponding to the maximum continuous hand welding current. Each power source shall, therefore, have two rated currents, one for ac output and the other for dc output. Preferred output current ratings, for higher of the two rated currents, shall be:

150, 200, 300, 400, 500, 600, 900 and 1 200 A.

4.4.1 Minimum Hand Welding Current

The minimum hand welding current shall be not more than 20 percent of the rated current both for ac and dc output at the specified load voltage.

It is intended that name-plate of the welding transformer shall indicate the current not less than 20 percent of the rated current but while checking the conformity of this clause, the tolerance of current indicated in 9.2 should be taken into account.

4.4.2 Minimum Automatic Welding Current

It shall be a matter of agreement between the purchaser and the supplier.

4.4.3 Maximum Hand Welding Current

The maximum hand welding current shall not exceed 1.35 times the corresponding rated ac and dc currents, respectively at the specified load voltage.

4.5 Duty Cycle

The rated duty cycle at maximum continuous hand welding current shall be taken as 60 percent; the total duration of each cycle shall be 5 minutes comprising a period of 3 minutes of load followed by a period of 2 minutes of no-load operation.

4.5.1 The rated duty cycle at maximum continuous automatic welding current shall be taken as 100 percent. Duty cycles other than 100 percent shall be a matter of agreement between the purchaser and the supplier.

4.5.2 The rated duty cycle at maximum continuous semi-automatic welding shall be a matter of agreement between the purchaser and the supplier.

4.6 Tolerance on Open Circuit Voltage

The permissible tolerance for the open circuit voltage(s) shall be ± 5 percent subject to limitation given in 4.3.

5 NORMAL SERVICE CONDITIONS

5.1 This standard applies to ac/dc arc welding power sources operating under the following normal service conditions (*see also* 11.8.3):

- a) Reference ambient temperature 40°C, and
- b) Altitude not exceeding 1 000 m.

6 DESIGN AND CONSTRUCTION

6.1 The rectifier assembly shall be isolated from the mains supply by a double wound transformer. Output terminals shall be insulated from the enclosure and shall be suitably protected against accidental or inadvertent contact.

6.2 Monocrystalline rectifiers shall be of adequate current carrying capacity and able to withstand, with surge devices, if fitted, transient voltages likely to occur from arc welding and allied processes. These rectifiers shall comply with IS 3895 : 1966.

6.3 Polycrystalline rectifiers (metal rectifiers) shall comply with IS 2511 : 1963, except for the voltage test, which shall be in accordance with 11.8 of this standard.

6.4 Where forced draught cooling is used, an automatic device which switches off the rectifier or reduces the output to a safe level in the event of inadequate airflow, shall be fitted.

6.5 The rectifier assembly shall be of adequate capacity such that its temperature-rise shall not exceed the value stipulated by the rectifier manufacturer at the rated output.

6.6 The arc welding power source shall be capable of withstanding:

- a) the full specified supply voltage without the necessity for reforming the rectifier cells by the application of reduced voltage, and
- b) an ac voltage instantaneously applied and maintained for 5 minutes which is 10 percent higher than the voltage appropriate to the selected primary voltage tapping. It shall also be able to withstand repeated switching off the ac supply at the same excess voltage when the dc output terminals are not connected to an external load.

6.7 Frame and Enclosures

The arc welding power source shall be so manufactured that it has the strength and rigidity necessary to withstand rough usage. It shall be provided with an enclosure or tank which shall enclose all live metal parts other than a flexible supply cord or cable and output terminals.

6.7.1 The enclosure or tank shall be so constructed as to exclude vertically falling water or dirt.

6.7.2 The enclosure of the tank shall be provided with suitable lifting lugs. In case of oil immersed power sources, an oil level indicator and a drain plug shall also be provided.

6.8 Earthing

Two earthing terminals shall be provided for two separate and distinct connections to earth of all metallic parts which are not intended to carry current. Earthing terminals shall be suitably protected against corrosion and shall be metallically clean. Earthing terminals shall be indelibly marked with the symbol \perp .

6.9 Protection Against Corrosion

All metallic parts and surfaces of assembly shall be suitably protected against corrosion.

7 CAPACITORS

7.1 Capacitors may be used to improve the power factor to approximately 0.85 lagging at 50 percent of the higher of the two maximum continuous hand welding currents and the specified load voltage (*see* Table 1).

7.2 The capacitors, if provided as part of the arc welding power source, shall conform to IS 2834 : 1986.

7.3 The capacitor shall be so connected that it is switched off with the arc welding power source.

**Table 1 Welding Current and
Welding Load Voltage**

(*Clauses 7.1, 9.2 and 11.5*)

Welding Current	Welding Load Voltage
A	V
150	26
200	28
300	32
400	36
500	40
600 and above	44

NOTE — The above load voltages are based on the formula $U = 20 + 0.04I$ where U is the load voltage and I is the load current ; this formula is applicable to all welding currents up to 600 A.

8 CONTROL AND PROTECTIVE DEVICES

8.1 If a switch, controller or circuit breaker is employed in the rectifier type arc welding power source, it shall be suitable for the particular application and shall conform to the relevant Indian Standard(s).

8.2 Contacts of all regulating taps, if provided, shall be such as to make positive contact between moving and stationary contacts. Visual indicator shall be provided to indicate the current setting.

8.3 Remote Control Devices

Remote control devices, if provided, shall not operate at voltage exceeding 110 V. For the supply to the control circuits, power shall be taken from a winding electrically isolated from the supply mains.

9 PERFORMANCE

9.1 The arc welding power source shall be capable of operating continuously maximum continuous hand welding current at the specified duty cycle (see 4.5) without overheating.

9.2 Indication and Accuracy

The arc welding power source shall carry a means of indicating the load current which takes into account the relationship between conventional load voltage and conventional welding current as given in Table 1. The accuracy of this indication shall be within ± 10 percent of the true value unless the maximum output current exceeds ten times the minimum output current. In this case, the accuracy at minimum current shall be:

$$\pm \frac{I_{Max}}{I_{Min}} \text{ percent}$$

and the accuracy at maximum current shall be ± 10 percent, with the accuracy varying linearly between these two values.

Whatever the method of regulation, the difference between the indicated currents corresponding to two successive positions of the setting device shall in no case exceed 15 percent of the higher of the two indicated currents.

NOTES

1 Subject to agreement between the purchaser and the manufacturer, scales graduated to indicate the current under other than conventional load voltages may be fitted for specific purposes.

2 In exceptional cases where because of the design of the welding equipment (for example, devices with dual control) it is impracticable to obtain a graduated scale for currents for conventional load voltage, it is recommended that the manufacturer provides on the equipment an ammeter of class index 2.5 [see IS 1248 (Part 2) : 1983], properly damped to indicate the welding current.

10 MARKING

10.1 The following information shall be given on the rating plate:

- a) Manufacturer's name or trade-mark;
- b) Reference to Indian Standard, that is, Ref IS 6008 : 1989;
- c) Type and manufacturer's serial number;
- d) Range of welding current (minimum and maximum) : for ac and dc;
- e) Maximum continuous hand welding current : for ac and dc;
- f) Maximum continuous automatic welding current : for ac and dc;
- g) Duty cycle at maximum current;
- h) Input current at rated output at 60 percent duty : for ac and dc;
- j) Rated input voltage, frequency and number of phases;
- k) Open circuit voltage, minimum and maximum, for ac and dc;
- m) Type of cooling;
- n) Mass;
- p) Class of insulation;
- q) Country of manufacture; and
- r) A warning worded as follows:

WARNING : Currents in excess of the following are for intermittent use only:

For hand welding ... Amperes

For automatic welding ... Amperes

10.2 The ac and dc arc welding power sources shall be fitted with two current calibration charts, for ac and dc output.

10.3 The polarity of the output terminals meant for dc shall be marked in relation to polarity in the following manner:

- a) Positive terminals as '+', and
- b) Negative terminals as '-'.

In case a polarity changeover switch is provided, the polarities marked are for straight connections only.

11 TESTS

11.1 Type Tests

Tests shall be carried out to prove compliance with all the requirements of this standard.

11.1.1 These tests may be carried out by mutual agreement between the purchaser and the supplier and if the records of type tests on arc welding power source which, in essential detail, is

representative of the one being purchased are furnished, the purchaser may accept these as evidence of 'type tests' (see 3.15) instead of actual tests. Type tests and their sequence shall be as follows:

- a) Insulation resistance test (11.3),
- b) Over voltage test (11.4),
- c) Open-circuit voltage test (11.5),
- d) Load characteristics test (11.6),
- e) Short-circuit test (11.7),
- f) Temperature-rise test (11.8),
- g) High voltage test (11.9), and
- h) Insulation resistance test (repeated) (11.3).

11.2 Routine Tests

The routine tests and their sequence shall be as follows:

- a) Insulation resistance test (11.3),
- b) Open-circuit voltage test (11.5),
- c) Load characteristics test (11.6),
- d) Short-circuit test (11.7),
- e) High voltage test (11.9),
- f) Insulation resistance test (repeated) (11.3).

11.2.1 A certificate of routine tests shall be furnished by the manufacturer which shall show that each of the arc welding power source had been subjected to the tests specified in 11.2 and that it complies with the requirements specified in this standard for these tests and that each of the arc welding power source has been found to be sound electrically and mechanically and is in working order in all particulars.

11.3 Insulation Resistance Test

For the purpose of this test, the rectifier cells shall be short-circuited on both the ac and dc sides while remaining connected to the transformer. Protective or filter devices or capacitors shall be disconnected or short-circuited as desired.

11.3.1 The insulation resistance before and after high voltage test shall be not less than 2 megohms. The insulation resistance shall be measured with dc voltage of about 500 V applied for a sufficient time for the reading of the indicator to become practically steady, such voltage being taken from an independent source or generated in the measuring instrument.

11.4 Over Voltage Test

An over voltage test shall be made as specified in 6.6 followed by repeated switching off the ac supply, 50 times, at the same excess voltage when

the dc output terminals are not connected to an external load.

11.5 Open-Circuit Voltage Test

With the input side connected to the rated input voltage and output side open-circuited, the open-circuit voltage shall be measured for both ac and dc output.

11.6 Load Characteristic Test

For the purpose of this test, the input side of the arc welding power source shall be connected to rated input voltage and the output terminals shall be connected to a variable resistive load. The associated load currents and load voltages shall be as given in Table 1.

11.7 Short-Circuit Test

Steady short-circuit current at maximum setting within the range specified shall be not more than 200 percent of the welding current corresponding to this setting. Under short-circuit conditions, the voltage between output terminals shall not exceed 3 volts.

NOTE — Care shall be taken to ensure that this test does not take more than 10 seconds.

11.8 Temperature-Rise Test

11.8.1 Test Conditions

11.8.1.1 The load should be a non-inductive resistance at the appropriate load voltage. A tolerance of ± 10 percent shall be allowed on the value on this load voltage.

11.8.1.2 Test shall be made at the rated input voltage.

11.8.1.3 Arc welding power sources suitable for hand welding shall be tested for temperature-rise at a current equal to the maximum continuous hand welding current and at the duty cycle equal to 60 percent, for ac and dc output.

11.8.1.4 Arc welding power sources suitable for both semi-automatic and automatic welding shall be tested for temperature-rise at a current equal to the maximum continuous automatic welding current and at a duty cycle equal to 100 percent, for ac and dc output.

11.8.1.5 The temperature-rise test shall continue until steady maximum temperature is obtained. If the temperature-rise does not vary by more than 20°C per hour, it is considered that steady temperature has been achieved.

11.8.2 When measured in accordance with IS 9678 : 1980, the temperature-rise shall not exceed the limits specified in Table 2.

11.8.3 For ambient temperature exceeding 40°C or altitude more than 1 000 m or both, the derating factor shall be subject to agreement between the purchaser and the supplier.

11.9 High Voltage Test

For the purpose of this test, the rectifier cells shall be short-circuited on either or both the ac and dc sides while remaining connected to the transformer.

NOTE — Protective or filter devices or capacitors shall be disconnected or short-circuited as desired.

11.9.1 As type test, this test shall be applied at the conclusion of the temperature-rise test.

11.9.2 The test shall be made with a single-phase alternating voltage as nearly as possible of sine-wave form and of any convenient frequency between 40 and 60 Hz.

11.9.3 The rms or peak value of the applied voltage shall be measured. The rms value shall be as follows:

- a) For the transformer alone when tested prior to inclusion in the complete unit — 2 000 volts;
- b) For the complete unit except as for (c) below 1 500 volts; and

- c) For all auxiliary circuits, not exceeding 110 volts to earth — 1 000 volts.

11.9.4 The appropriate voltage, obtained from a separate source, shall be applied for 60 seconds to each winding in turn, between the winding under test and the remaining windings, core, frame and tank or casing of the transformer, connected together and to earth.

11.9.5 The test shall be commenced at a voltage not greater than one-third of the test value, and shall be increased to the specified value as rapidly as is consistent, with its magnitude being indicated by the measuring instrument. At the end of the test, the voltage shall be reduced rapidly to less than one-third of its full value before switching off.

NOTE — This test should not be carried out when the insulation resistance value is below 2 megohms.

11.9.6 If this test is required to be repeated, the test voltage levels shall be reduced to 75 percent of the original values.

Table 2 Limits of Permissible Temperature-Rise
(Clause 11.8.2)

Sl No.	Part of Machine	Temperature Rise in °C (See Note 1)									
		Class of Insulation									
		A		E		B		F		H	
		T	R	T	R	T	R	T	R	T	R
1	Insulated windings	55	60	65	75	70	80	85	100	105	125
2	Oil	50	—	—	—	—	—	—	—	—	—
3	Uninsulated parts including cores not in contact with insulated winding	The temperature-rise shall in no case reach such a value that there is risk of injury to any insulating material on adjacent parts or to the welding power source in any respect.									

NOTES

1 Method of temperature measurement, by thermometer (T), by resistance (R).

2 The numerical values quoted for Class F and H insulation should be considered as tentative only and may be revised when more practical experience is available. If Class C insulation is used, the temperature-rise shall be a matter of agreement between the purchaser and the supplier.

3 For details of classes of insulation, see IS 1271 : 1985.

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